Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

OCTOBER, 1916.

THE HISTORY OF LABORATORY HEATING APPLIANCES.

By S. C. BRADFORD.

ALTHOUGH the furnace was the most obvious source of heat available for early chemical and metallurgical operations, the use of burning glasses and mirrors appears to have been known from very early times. An oval plano-convex lens of quartz, dating from about 640 B.C., was discovered by Layard in the ruins of the north-west palace of Nineveh. Aristophanes refers (about 423 B.C.) in "The Clouds" to the use of burning glasses by pharmacists; and, although Archimedes may not have used a mirror to destroy the Roman fleet, it is probable that he constructed an instrument of the kind. Large lenses were useful for the production of intense heat. One used by Tschirnhaus (about 1694) led to the discovery of porcelain; and a similar contrivance with hollow lenses, fifty-two inches in diameter, filled with water was employed by Lavoisier in 1772 to determine the nature of the products of combustion of the diamond. Two years later Priestley utilised a burning glass to concentrate the sun's rays on red precipitate in his classical preparation of oxygen.

Furnaces of many forms have been employed from the earliest times in metallurgical processes. There is strong probability that copper was known in Egypt and in Chaldaea about 5000 B.C., and iron from about 1000 years later. The earliest chemical laboratories of which we have any knowledge are those connected with the Egyptian temples, where the priests prepared the incense, oils, and other substances used in the temple services. On the granite walls were carved the recipes and processes, which may still be read. There are depicted various forms of furnaces, blowpipes, bellows, and crucibles, not differing greatly from those recently or still in use. The history of the blowpipe has been traced in a previous paper.* A great variety of furnaces was employed by the alchemists, who in their researches on the transmutation of metals were familiar with the processes of distillation, evaporation, digestion, and cupellation. Their masterpiece was the *athanor*, deathless, because the fire could be maintained indefinitely. This was effected by an air-tight tower at the back of the furnace, which held a supply of charcoal in such a manner that the fuel was replenished as it burnt in the grate. Figure 159 is taken from Libavious, *Alchymia*, 1606. Of the furnaces in use in more recent times Brande designed a brick furnace about 1820, which came to be largely employed for laboratory purposes. It was provided with rings for supporting vessels over the fire, and with a sand-bath and hot-air chamber. Luhmé's cylindrical iron furnace was also much in demand. A convenient form of portable furnace, invented by Black and modified by Knight, was to be found in most laboratories; and Sefström's blast furnace was well known. In addition to these, small fireclay furnaces of various sizes, including ones for heating test-tubes, were used on the bench, with charcoal as fuel, from the beginnings of chemistry.

The principal drawback to furnaces burning solid fuel was the difficulty of maintaining any approximation to a constant temperature for a considerable

* "KNOWLEDGE," August, 1915.

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time. Consequently, where great heat was not required, so-called lamp furnaces were often used. According to Libavious, an *athanor*, with a spherical glass lamp as the source of heat, was devised by Henricus Khunrad in 1599. A type (see Figure 160), which had come later into general use, was described by Baumé,* and became associated with his name. The lamp was provided with from four to six wicks, so that the heat might be regulated by lighting only as many as were required. It was fed with olive oil, supplied from an external reservoir on the bird-fountain principle. The oil was contained in an inverted flask, dipping into a cup beneath, into which the oil flowed until its surface rose above the lower edge of the neck of the flask, or a small hole in its side. In this way the oil was maintained at a fairly constant level in the lamp. A sand-bath and water-bath were also provided. Their objectionable properties of smell, smoke, and leakage prevented these lamp furnaces from being so largely employed as might otherwise have been the case. The invention, in 1782, of the Argand circular burner, which was provided with a chimney to increase the supply of air to the flame, and so allow of complete combustion, paved the way for the introduction of a really serviceable lamp furnace (see Figure 163), which was designed by Guyton de Morveau in 1797. The many advantages of the apparatus may be expressed in his own words † :—

"Le corps de la lampe étant lui-même susceptible de mouvement sur sa tige, on a la facilité de le rapprocher ou de l'éloigner à volonté des vaisseaux qui restent fixes; ce qui indépendamment de l'élévation ou de l'abaissement de la mèche, donne le moyen d'échauffer les cornues par degrés, de modérer, de supprimer le feu instantanément, de le tenir enfin pour plusieurs heures à un degré constant et déterminé, depuis l'évaporation presque insensible des dissolutions cristallisables, jusqu'à l'ébullition des acides; propriétés que n'eut jamais l'*athanor* si vanté des chimistes, et dont l'avantage sera bien senti par ceux qui savant que les manipulateurs les plus exercés et les plus attentifs éprouvent de fréquents accidents, et perdent à la fois les résultats de leurs opérations et de leurs vaisseaux, faute de pouvoir se rendre maîtres du feu."

The apparatus was practically an Argand lamp, with a shortened chimney, and provided with a wooden base and supports for apparatus. These latter are of considerable interest, as indicating the origin of the retort stand. The older laboratory furnaces were supplied with rings, like those still used in water-baths, or were shaped above to support the vessels requiring to be subjected to the heat of the fire. When oil lamps came to be used as the source of heat, it was necessary to add the means of holding the apparatus to be heated. This Guyton did by attaching sliding rings to an extension of the lamp standard. His lamp was soon modified with the substitution of a short copper chimney for the glass one, and the provision of a standard of sufficient height to take the rings itself. Subsequently chemical lamps were made without standards, and separate retort-stands were required (see Figure 161), which retained the form of the standard of the original Argand lamp, and were often supplied with a movable table for the support of the lamp. Such retort-stands, with round bases, remained in use until about 1850, although more convenient modifications, with flat rectangular feet, were quickly introduced.

The Argand lamp was adapted for use with alcohol by Berzelius in 1819. The circular flame was convenient for heating crucibles, and, on account of its size, a considerable amount of heat was developed. But since the spirit-flame is naturally smokeless and less hot than that of oil, a large access of air is not required; so that it was found that lamps, provided with one or more flat wicks, gave greater heat, and these were largely adopted. Small glass spirit lamps, similar to those still occasionally used, are depicted in Griffin's "Chemical Recreations," second edition, published as early as 1823. The description is interesting: "Alcohol burns with a flame which is large or small, according to the size of the surface of the cotton-wick. It gives no smoke; it has no disagreeable smell; nor does it spoil anything if it happens to be overturned. But, with its many advantages, it has one great disadvantage, namely, that it cannot be used much, on account of the great expense attending the consumption of the spirit of wine." These lamps were originally provided with brass wick-holders. Stoneware ones were introduced later by Griffin. A brass spirit lamp, in use about 1840, is shown in Figure 162. Like the Berzelius lamp, this is provided with a standard, carrying rings for retorts.

The beginning of the nineteenth century saw the invention of the combustion furnace. The earliest analysis of an organic compound was carried out by Lavoisier in 1781, who determined the carbon and hydrogen in alcohol by burning it in a lamp under a bell-jar, and weighing the carbon dioxide absorbed by potash. The first really accurate method of ultimate organic analysis was developed by Berzelius in 1814, who used a furnace improvised of bricks, as shown in Figure 164. The original of the photograph was reconstructed in the Science Museum, South Kensington, from Berzelius' detailed description, and differs fundamentally from the figure in Roscoe and Schorlemmer's "Organic Chemistry."

The dried substance to be examined was heated with potassium chlorate in the combustion tube, surrounded by thin tinplate, and the water and carbon dioxide evolved were collected, the former in the small spherical receiver and long calcium chloride tube, and the latter over mercury in the bell-jar, where it was absorbed by solid potash, sub-

* *Chimie Expérimentale*, page 1764.

† *Annales de Chimie*, XXIV, 310.

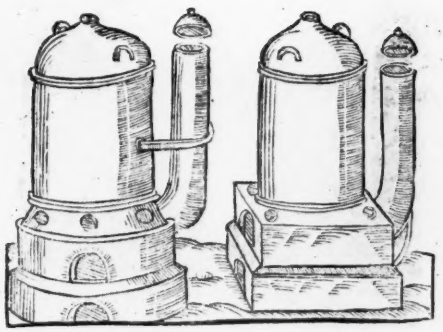

FIGURE 159. A Furnace of 1606.

FIGURE 162.
A brass Spirit Lamp of 1840. From an example in the Science Museum.

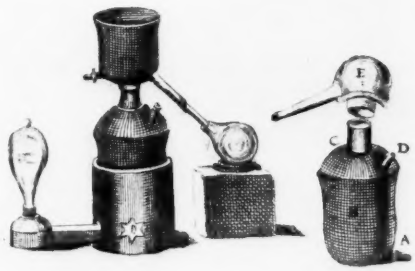

FIGURE 160. A Lamp Furnace of 1599.

FIGURE 161.
An early form of Retort Stand. From a reproduction in the Science Museum.

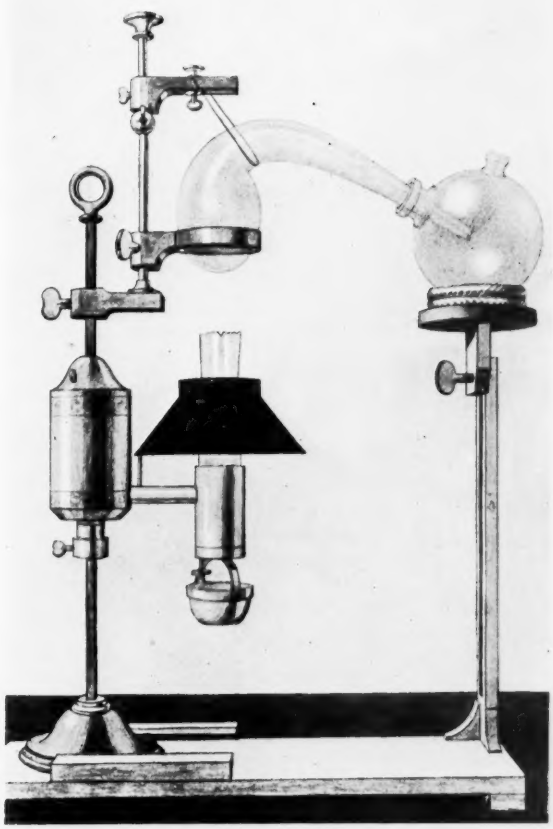

FIGURE 163.
A circular Argand Burner of 1797. From a water-colour drawing in the Science Museum, South Kensington.

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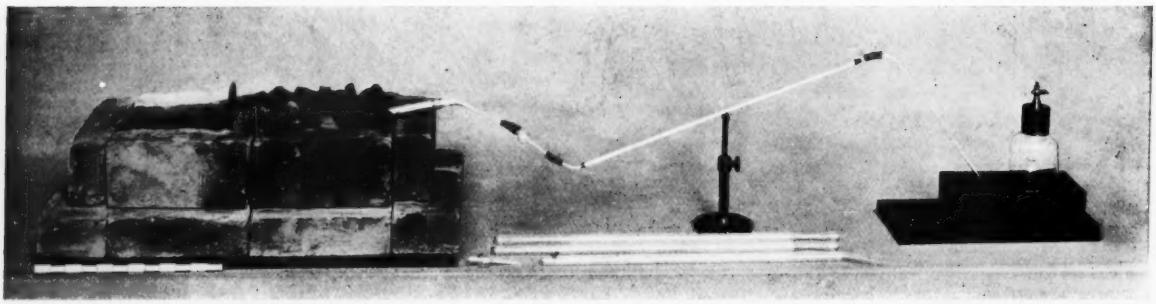

FIGURE 164. The Furnace improvised by Berzelius in 1814. Reconstructed in the Science Museum, South Kensington.

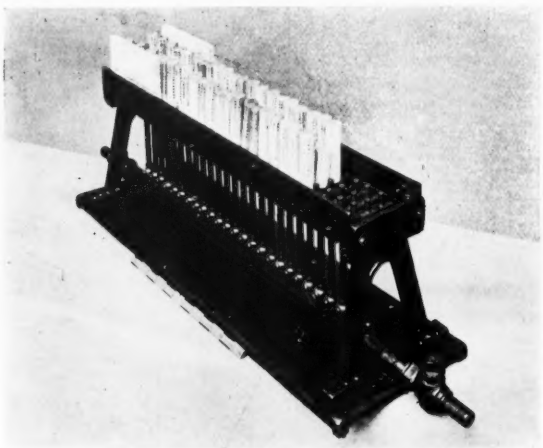

FIGURE 165. A Furnace designed by Hoffman in 1838.
From an example in the Science Museum.

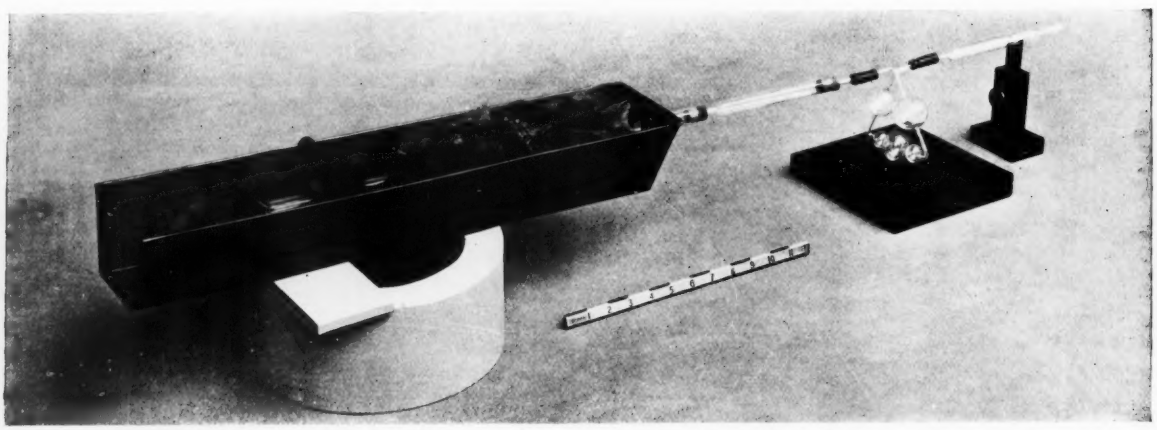

FIGURE 166. Liebeg's Apparatus, perfected in 1831. From a reproduction in the Science Museum.

sequently introduced in the small bulb seen within. The method was perfected, and reduced to practically its modern form, by Liebig in 1831 after seven years' work. His apparatus, with charcoal furnace and potash bulbs, is represented in Figure 166. The disadvantages of charcoal led to attempts to replace it by alcohol, and furnaces burning spirit, which were used to a considerable extent, were constructed by Cooper in 1823, and Hess in 1837.

Soon after coal gas was first supplied to the public in Westminster, in April, 1813, the principle of the Argand circular flame was applied to its combustion, and burners of this type came into use in laboratories. At first no gauze cap was used, but the gas burned at an annular slot below the copper chimney. Such an arrangement was stated in 1849 " to leave nothing to be desired." However, a year or two later a smokeless flame was obtained by fitting a cap of wire gauze on the chimney, above which the gas was lighted, having mixed with air in its passage up the tube. At about this time an interesting method of burning coal-gas was invented by Remington. A vertical gas-pipe, fixed to a table, was arranged to open beneath a funnel-shaped tube, and the gas was lighted at the apex, where it burnt with a blue flame of great intensity which was more compact than that of the Argand burner. The diameter of the top of the tube was small enough to prevent the flame from running down the tube. The neck of a broken retort was said to answer the purpose. The Bunsen burner was introduced in 1855. The story of its invention is told by the late Sir Henry Roscoe* :—

" Some short time before the opening of Bunsen's new laboratory the town of Heidelberg was for the first time lighted by gas, and Bunsen had to consider what kind of gas-burner he would use for laboratory purposes. Returning from my Easter vacation in London, I brought back with me an Argand burner, with copper chimney and wire-gauze top, which was the form commonly used in English laboratories at that time for working with a smokeless flame. This arrangement did not please Bunsen in the very least: the flame was flickering, it was too large, and the gas was so much diluted with air that the flame-temperature was greatly depressed. He would make a burner in which the mixture of gas and air would burn at the top of the tube without any gauze whatsoever, giving a steady, small, and hot non-luminous flame under conditions such that it not only would burn without striking down when the gas supply was turned on full, but also when the supply was diminished until only a minute flame was left. . . . After many fruitless attempts and many tedious trials he succeeded, and the ' Bunsen ' burner came to light."

A reference in Greville Williams's " Handbook of Chemical Manipulation," 1857, throws some light on the original form of the burner: " A burner of a very convenient kind for mixed gas and air† has lately been introduced. It consists of a brass tube, of about five-eighths of an inch in diameter, sliding on a fish-tail burner. The air enters by holes at . . . [the base], the amount being regulated by means of a small slide."

In the course of experiments made in order to obtain a higher temperature and larger flame than were possible with the Bunsen burner, it was found that increasing the size of the burner was not advantageous, as enlargement of the diameter of the tube reduced the speed of the gaseous mixture. Better results were obtained by grouping several small burners in a ring, and the idea of the annular burner was again revived. The Argand principle was first applied to the combustion of a mixture of gas and air by Maste in 1880, with the production of a compact and hot flame. In the same year Fletcher introduced a burner with the horizontal mixing tube. The air entered through two openings, one on either side of the gas-jet, into a horizontal tube, and the mixture passed into a cup-shaped mixing chamber, covered with copper gauze, above which it burned. Three years later he adapted the Maste principle, allowing the gas to burn at an annular opening above a ring-shaped mixing chamber of circular section. The later substitution of a number of holes, or slots, for the annular opening resulted in the modern ring burner.

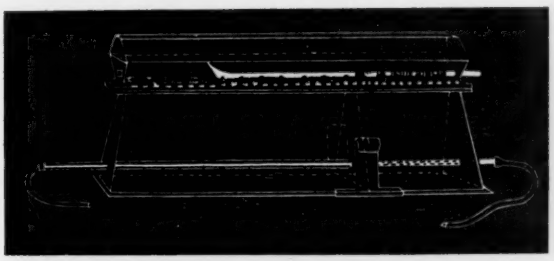

FIGURE 167.

In 1875 Wallace pointed out the desirability of devising a burner which should produce a more homogeneous flame from that of Bunsen. Wallace showed that, when the gas supply is slowly reduced, the hollow space in the centre of the Bunsen flame becomes smaller as the proportion of air increases; and, at the same time, the flame grows hotter until the hollow space finally disappears and the gas explodes in the tube. The problem was then to construct a burner in which a larger proportion of air should be mixed with the gas without danger of the flame striking back. This was accomplished in the Wallace burner by surmounting the tube with an iron plate pierced with small holes. A greater proportion of air was admitted than in the Bunsen burner, and a flame was produced which was solid to the core and intensely hot, the cooling effect of the iron plate preventing the combustion from passing into the tube. This principle was adopted in the Fletcher safety burner, invented some ten years later. The iron cap was replaced by wire gauze, and air was admitted to the mixing tube through gauze below. A thorough mixture was thus produced, which burnt with a homogeneous

* *Trans. Chem. Soc.*, 1900.

† " Said to be invented by Bunsen."

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smokeless flame, which would not strike back even when the gas was turned quite low.

The extreme ease with which gas flames may be regulated, and their cleanliness and economy, led chemists to endeavour to substitute them for charcoal in combustions. Dr. Lionel Beale was perhaps the first to suggest this method. His apparatus is shown in Figure 167. It consists of an iron chamber, at the lower part of which is placed a long brass tube, perforated its whole length with small holes, from any number of which, by moving a piston, the gas can be permitted to issue and mix with the air of the chamber. The mixed gases pass upwards, and are ignited above the surface of iron wire gauze, which is stretched over the top of the chamber. By means of a sliding partition, which fits the iron chamber, the flame can be adjusted according to the length of the combustion tube to be heated. Similar arrangements were made by Liebig in 1853 and Hofmann in 1854. All these proved to be unsatisfactory, and Hofmann designed a furnace in 1858 (see Figure 165), in which use was made of the perforated hollow clay burners, closed at one end, known as "Atmopyres." The gas, issuing from ordinary batswing burners in three parallel rows, mixed with air within the atmopyres, and burnt at their surface with a hot smokeless flame. This apparatus was used for many years until it was eventually superseded by types in which Bunsen burners were used.

The intense heat of the electric arc was utilised in the first successful electric furnace invented in 1878 by Siemens, and has been since employed by Moissan and others in notable researches. A type of resistance furnace, in which a high temperature is obtained by passing the current through a rod or tube of carbon, was devised by Despretz in 1840, improved by Borchers in 1880, and is still in use. But it was not until after the invention of the Heräus furnace in 1901–3, in which the current is passed through a ribbon of platinum wound over a silica tube, that the electric-resistance furnace began to be largely used in the laboratory.

On later forms the platinum ribbon is replaced by high-resistance wire, which lasts long enough to effect a considerable saving in expense. Small electric heaters are convenient for use with organic liquids, and have the advantages over the water-bath of cleanliness, portability, and absence of steam and condensed moisture. These heaters should be more generally employed.

The applications of electricity to laboratory heating appliances increase from time to time, but it does not appear probable that the near future will see the displacement of Bunsen's simple invention.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

A METEOR SHOWER FROM WINNECKE'S COMET.—Mr. Denning, at Bristol, detected a brilliant shower of meteors on June 28th last, from the radiant 231°+54°, which was not in his catalogue of showers. Both he and Dr. Charles P. Olivier independently concluded that it was connected with Winnecke's Periodic Comet. The latter gives the following elements for the meteors and the comet's elements for the apparition of 1909. He has adopted 203°+53° for the radiant.

	Meteors.	Comet.
	° ′	° ′
Inclination	20 51	18 17
Long. Perihelion ...	268 19	271 37
Ascend. Node	96 55	99 21
Perihelion Distance ...	1·011	0·9725

These elements are taken from *Harvard College Observatory Bulletin* 614. The agreement is sufficiently close to make the identity almost certain. Absolute agreement is not to be expected, since in other cases the meteor orbits have diverged considerably from that of the parent comet. There is an interesting explanation of the fact that the meteors were not seen earlier. It is that the perihelion of the orbit was formerly well inside the Earth's orbit, but has been steadily moving outwards under the influence of planetary perturbations. Thus in 1875 its distance from the Sun was 0·829; in 1886, 0·885; in 1892, 0·887; in 1898, 0·924. We may anticipate that the meteors will intersect the Earth's orbit for a considerable period. Showers may be looked for each year about June 28th. There is likely to be a conspicuous one in 1921.

DISTRIBUTION OF RADIATION OVER THE SUN'S DISC.—It has long been known that the darkening of the Sun's limb is greater on photographs than in eye-observations. The cause is the same that renders the setting Sun red; the rays of short wave-length are more absorbed in the Sun's atmosphere than the long red ones. Messrs. Abbot, Fowle, and Aldrich have made a long series of bolometric observations with the Tower telescope at Mount Wilson. They give, in *Smithsonian Miscellaneous Collections* (Vol. LXVI, No. 5), a table of the proportion of radiation for light of various wave-lengths at different distances from the Sun's centre. For example, at 0·95 of the radius from the centre the brightness for the short waves is 0·43 of that at the centre; for the long waves, 0·73. They consider that the phenomenon is due, not to absorption in the Sun's atmosphere, but to the fact that the light at the centre comes to us from a great depth of photosphere; while at the edge of the disc it comes from a much smaller depth, and so the effective temperature of the radiating surface is less. Their work indicates that the solar temperature and, consequently, the limb-absorption are greater at sun-spot maximum. On the other hand, they believe in the existence of short-period variations in the solar radiation, and conclude that for these changes the limb-darkening is diminished for increased radiation.

THE PLANETS AND THE SUN-SPOT PERIOD.—M. V. Kostitzin has a note on this subject in *Comptes Rendus* for August 21st. Some observers have suspected traces of a terrestrial effect on solar activity. He points out that,

if this is real, it could hardly arise from the eccentricity of the Earth's orbit, or its inclination to the solar equator, for other planets would have a higher factor in these respects. He suggests that it may be an electro-magnetic effect, varying as the rotational velocity of the planet, as the size of the angle between the planetary and solar axes, and inversely as the cube of the distance from the Sun; it would also depend on the size of the planet and the extent of its atmosphere: but the factor due to this cannot be evaluated. Mercury and Venus would have no effect if they always turn the same face to the Sun; while Jupiter's effect would be reduced by the small inclination of axes, those of Saturn, Uranus, and Neptune by their immense distance. Thus the theory would explain why the Earth should have a greater influence on sun-spot activity than any of the other planets. The idea is, of course, highly speculative, but it deserves to be tested.

MIRA CETI.—M. Fényi de Roy has published a paper on the variation in light of this star. He enlarges on the fact that the maximum light is subject to considerable variation, and comments on M. Bemporad's attempts to reduce these changes to a formula. There is some appearance of regularity in the variations. The following list gives the magnitudes at maximum from 1894 to the second maximum of 1915 (there are two maxima in 1896, 1906, 1915, the period being eleven months): 2·7, 3·8, 3·7, 4·0, 3·5, 2·7, 3·8, 3·4, 2·9, 3·6, 4·4, 2·2, 3·5, 3·6, 3·2, 3·2, 3·3, 3·0, 3·0, 3·8, 3·0. These figures show a range of two magnitudes in the maximum light, but it is difficult to trace a definite law of change. When the maximum falls in April it is difficult to observe it owing to the star's proximity to the Sun. Observers south of the Equator do not lose it for so long as northern ones, and it is noted that since 1904 Mr. Westland has observed it diligently from New Zealand. The light at minimum does not fluctuate so much as at maximum, but the time interval from maximum to minimum seems to vary, being ninety-seven days after a faint maximum, whereas it sometimes rises to one hundred and twenty-eight days after a bright one.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon), F.I.C.

AGRICULTURE AND THE WAR.—Apart from difficulties due to shortage of labour, the farmer has many problems caused by the war to solve. Among the most pressing of these is the necessity of choosing what fertilisers and feeding-stuffs he should use, under the present conditions, so as to obtain the best results without paying too much for them. Much valuable chemical information on these points will be found in a paper recently contributed by Mr. A. Smetham to *The Journal of the Royal Lancashire Agricultural Society*, and reprinted in the form of a pamphlet.

Last year there were still considerable supplies of sulphuric acid available for the manufacture of superphosphate, but the increasing demand for the acid for munitions purposes is now interfering with the preparation of the ordinary compound manures. As a result of this, fertilisers containing much less soluble phosphate are being supplied, their value as fertilisers depending upon the proportion of phosphate soluble in two-per-cent. citric acid solution. For example, bone meal contains about forty-two per cent. of "citric-soluble" phosphate and fish guano about seventeen per cent. Basic slag also contains a high proportion of available phosphate, while at the other end of the scale are the mineral phosphates, which in the untreated condition are of very little value as fertilisers for ordinary soils. In the light of his experiments Mr. Smetham considers that farmers may accept without hesitation the new guarantees as to the availability of the phosphates in artificial manures. With regard to the nitrogen, it is probable that in the future manures will show a tendency to decrease in the proportion of that constituent.

The supply of potash will still fall short, for so far no profitable method of extracting potassium salts from granite or other rocks has been devised to take the place of that obtained from the Stassfurt deposits of Germany. But, in Mr. Smetham's opinion, potash is much less important than phosphates and nitrogen for most soils, and the deficiency may be met by various means, such as the purchase of feeding-stuffs, the use of nitrate of soda, liming the soil, and the liberal use of other artificial manures.

With regard to feeding-stuffs, the outlook is not much more promising. The imports of oil-cake for March, 1916, were only 16,948 tons, as compared with 37,233 tons for the same month last year, and 34,898 tons in 1914. It is possible that this falling-off might be compensated to some extent by increasing the production of grass and forage crops by liberal manuring, but in any case it would be necessary to supplement home-grown crops by the use of concentrated feeding-stuffs. At the present time linseed and cotton-seed cake cost from £12 to £14 per ton, and it is therefore advisable that the farmer should avail himself of other feeding-stuffs which he has hitherto neglected. Among these are palm-kernel cake and meal from British West Africa, about five-sixths of which produce were shipped to Germany prior to the war. Copra, or coconut oil-cake, is also particularly suitable for dairy cattle, and three years ago, like palm-kernel cake, was mainly exported to Germany. Other valuable feeding-stuffs are sesame cake, which has a higher food value than linseed cake, and babassu-nut cake, made from the kernels of a South American palm (*Attalea funifera*). If the present dearth of linseed and cotton-seed cakes should prevail upon English farmers to use these and similar feeding-stuffs, the prejudice against them would soon vanish, and in the future Colonial producers will be encouraged to send their goods to this country instead of to Germany and Austria.

NUTRITIVE VALUE OF MUTTON AND LAMB.—Analyses of boneless meat from fresh New Zealand mutton and lamb have been made by Mr. A. M. Wright (*Journ. Soc. Chem. Ind.*, 1916, XXXV, 235). The results are given in tabular form, and show the amounts of the principal constituents in the different parts of the meat. It was not possible to trace any relationship between the market prices of the various cuts and their palatability as indicated by the amounts of mineral salts, nor between the prices and the proportions of fat, proteins, or meat bases.

GEOGRAPHY.

By ALEXANDER SCOTT, M.A., D.Sc.

THE MAPPING OF THE EARTH.—At the meeting of the British Association in Newcastle Mr. E. A. Reeves took as the subject of his presidential address to Section C "The Mapping of the Earth: Past, Present, and Future." In classical times the chief method of guidance in travelling was by means of the stars, at first without instrumental assistance, but latterly with the aid of the gnomon for the determination of latitude. The adoption of this instrument (by Pytheas and Aristarchus), and the invention of the astrolabe (by Hipparchus), greatly improved the accuracy of the observations. The first attempt at geodetic surveying was the measurement of the arc of the meridian by Eratosthenes. No further improvements in the methods resulted until the Portuguese and the Spanish in the fifteenth century commenced exploration on a large scale, the positions being fixed by means of the astrolabe, aided by sets of tables which constituted an early type of nautical almanac. The quadrant and octant—precursors of the sextant—were also devised about this time, their accuracy being increased by Newton; while the invention of the sextant and vernier induced further progress.

After the introduction of triangulation by Snell, the invention of the theodolite by Digges may be said to constitute the greatest advance in land surveying, as it

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facilitated the accurate determination of horizontal angles. Since that time improvements have been concerned mainly with the accuracy of base and angle measurements and with greater refinements in calculation. Thus we have the introduction of the invar tape, with its very low coëfficient of expansion, for base-line measurement; the application of wireless telegraphy in the determination of longitude; and the use of the plane table, with alidade, in detailed topographical work—all tending towards greater efficiency and the supersession of the older absolute methods.

The vast amount of work done in the last half-century is indicated in the address by two maps, showing the proportions of the land surface mapped in 1860 and at the present day. While in the former year one-thirtieth of the land surface of the globe had been triangulated, and the same proportion roughly surveyed, at the present time one-seventh has been the subject of accurate topographical surveys, one-twelfth has been mapped from non-topographical surveys and two-thirds from traverses. In the same period the area entirely unmapped has decreased from one-half to less than one-seventh. The chief unmapped areas comprise the desert parts of Asia, Africa, and Australia and portions of the silvas of the Amazon basin. The address concludes with a discussion of the factors, military and otherwise, which have been responsible for the surveying and mapping of the various regions of the earth.

GEOLOGY.

THE CRYSTALLINE FORMS OF CALCIUM CARBONATE.—Some of the workers at the Carnegie Institute at Washington have lately carried out a very complete investigation of the different forms in which calcium carbonate exists in nature. It was found that, in addition to calcite and aragonite, there is another form, to which the name of "μ-calcium carbonate" is given; while the existence of conchite, ktypeite, vaterite, lublinite, and other so-called mineral species is finally disproved. It is also suggested that the so-called "amorphous" calcium carbonate is really an aggregate of very fine particles of crystalline varieties. It was not found possible to determine the conditions under which aragonite is formed. This mineral appears to be quite stable at ordinary temperatures, but changes to calcite on heating and in the presence of water without heat. Its formation from solutions is also favoured by the presence of sulphates: this is in agreement with the common occurrence of aragonite in the deposits from mineral springs. Finally, it is shown that the chemical tests hitherto used to distinguish between calcite and aragonite are useless and even misleading.

R. H. R.

THE ORIGIN OF DEEP OCEANS.—In a paper entitled "The Problem of Continental Fracturing and Diastrophism in Oceania," published in *The American Journal of Science* for August, 1916, Professor Schuchert advances some very interesting opinions on the time of origin and relative permanence of the deep oceans. He points out that as the result of deep-sea expeditions it has been shown that the organisms of the oceanic abysses show no relation whatever to palaeozoic forms, and very little to those of Triassic times. The earliest fauna from which they can be derived with certainty is that of the Jurassic. This fact would seem to show that before the latter period there were no really deep seas, and that these only came into existence at about that period. This may be due to two causes; firstly, the decreasing of the earth's radius, which would tend to increase the relief of the surface of the crust; and, secondly, the increase in the amount of water which is constantly being poured out from the interior of the earth as "juvenile water" by volcanoes and their associated deep-seated springs.

This increase in depth of the oceans was also accompanied by an enlargement of their areas owing to the foundering of old continents, those of Gondwana stretching from South America across South Africa to Southern India, and that of the South Western Pacific Ocean, which covered the area now occupied by Eastern Australia and Oceania. Following Suess, Professor Schuchert concludes that it is not necessary to assume any great continental uplift to account for the birth of continents, but that their origin dates back to pre-Cambrian time, the only considerable movement which has taken place being a negative or downward movement in the areas now occupied by the oceans. Since the South Western Pacific Ocean may be considered to be of the nature of a continental area, it is natural that some parts should be reëlevated into chains of islands, most of which have been formed probably during the late Mesozoic and Tertiary periods. As further evidence for the former continental condition of the South Western Pacific, it may be noticed that the great deeps are chiefly found outside the foundered continents in areas of the older and more permanent oceans.

W. H. W.

EAST AFRICA.—The recent military operations in the last remaining German colony have once more called attention to the geography of Eastern Africa. There is perhaps no region in the world where the configuration of the land and the water system depend so closely and so clearly on geological structure. The dominant feature of the whole of Eastern Africa is the great system of faults, running in a general north and south direction, with many local deviations. These have given rise to what are known as the "rift valleys." In these narrow trenches, bounded by parallel faults, lie most of the great lakes, with the notable exception of the Victoria Nyanza, which is a broad shallow sheet of water lying on the plateau between the rifts; while the other large lakes are deep and narrow in conformity with their position. Nowhere is this better shown than in Tanganika, which is bounded on both sides by fault-scarps. Towards the south the fault system extends through Portuguese territory, and is probably responsible for the remarkably straight coast line of Natal. As is well known, there are many volcanic mountains in East Africa, and it is interesting to note that in some parts, and especially in the Upper Nile valley, earthquakes are fairly frequent. They appear to be in close connexion with the faults, thus suggesting that the movements are still in progress. Indeed, there is some reason to believe that in the Tanganika region, within the last forty years, there have been changes in the relative levels of the fault blocks of sufficient magnitude to bring about changes in the direction of the drainage. Our knowledge of the eastern portion of the rift-valley system is still far from complete, and further geological explorations in that region will be awaited with interest.

R. H. R.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

LIGHTNING DANGER OF TREES.—From *The Scientific American* we learn that recent statistics have been collected in different parts of Germany as to the danger of different varieties of trees being struck by lightning. The result has been the following percentages: Oak, 32·1; larch, 9·5; fir, 3·8; pine, 1·8; scotch fir, 0·9; birch, 1·4; beech, 0·3; and alder, 0·0. The character of the soil is an important factor among others as to the lightning danger. Trees growing in moist soils and along the courses of rivers and brooks, and in the neighbourhood of ponds, are especially exposed to the danger. Trees with deep penetrating roots are more easily struck than those with shallow roots nearer the surface. As proof of this is the greater frequency of the apple tree being struck than the pear in the same orchard. It is also stated that the poplar stands first in danger before the oak, elm, ash, gum, and pear tree. Together with the beech, the least attractive to lightning are chestnut, maple, alder, and mountain ash. Between these two groups stand the apple, cherry, linden, and the walnut trees.

During thunderstorms it is advisable, therefore, to avoid oaks, poplars, all kinds of pine, willows, elm, and pear. If shelter is taken under a tree—which is always dangerous—it should not be under one standing alone.

COST OF BAD WEATHER.—Professor C. F. Talman, the Librarian of the U.S.A. Weather Bureau, in an interesting article on " The Weather " in *The Mentor*, gives some figures as to the monetary cost of bad weather. The Director of the British Meteorological Office recently declared that bad weather costs the farmers of the British Isles about one hundred million dollars (£20,000,000) a year. In the United States it has been estimated that a difference of one inch in the rainfall occurring during July in six States means a difference of two hundred and fifty million dollars (£50,000,000) in the value of the corn (maize) crop. The world over the damage wrought by hail storms is said to average about two hundred million dollars (£40,000,000) a year. In the city of Galveston a single hurricane once destroyed twenty million dollars' (£4,000,0000) worth of property and six thousand human lives.

CANADIAN METEOROLOGICAL SERVICE.—*The Monthly Weather Review* and *The Annual Reports* issued by the Meteorological Service of Canada have been discontinued with the end of 1915, and are now replaced by a new publication entitled *Monthly Record of Meteorological Observations in the Dominion of Canada and the Colonies of Bermuda and Newfoundland.* This will give data in more extended detail than formerly. The number for January, 1916, in addition to the usual monthly results from about six hundred stations, gives the hourly values of pressure, temperature, and relative humidity for eight selected stations. The result of the persistent far southerly course of the depressions was a continuance of northerly winds and almost unprecedented cold in British Columbia and the Western Provinces (in some places the mean temperature was as much as 30° below the normal) ; whereas the eastern half of the Dominion, which was under the influence of the constant flow of the succession of depressions, was for the most part unusually mild, with frequent precipitation largely as rain.

It will be remembered that during the same month (January) the temperature in this country was abnormally high, the mean for the Midlands being more than 7° above the normal.

MICROSCOPY.

By F.R.M.S.

THE LIFE-HISTORY OF A SOIL AMOEBA.—In Part 16 of Volume XVI of *The California University Publications in Zoology*, Charlie Woodruff Wilson describes " A Soil Amoeba," *Naeglaria gruberi*, which was kept in cultures under laboratory conditions for two years.

Ordinary binary fission was observed, as well as multiple fission, which is apparently rare. Under certain unknown conditions external budding occurs. Internal budding also takes place, but rarely. Encystment regularly ensues after a period of binary fission. Excystment occurs continuously in standing cultures, and may generally be induced by renewal of the culture medium. Most interesting is the enflagellation which occurs sparingly in cultures, and may be induced generally by the addition of distilled water and by the exposure of the films to the air at room temperature. There are two equal flagella, and the flagellate stage is of brief duration, rarely exceeding twenty-four hours.

PHOTOGRAPHY.

By EDGAR SENIOR.

TESTING SPEED AND EFFICIENCY OF SHUTTERS.—Although the total period during which a shutter is open may be determined with more or less accuracy in a number of different ways, the efficiency by which is understood the ratio between the amount of light admitted by the shutter and that which would be admitted by the lens, were the shutter fully open during the whole of the time, is a much more difficult matter to ascertain, as the only really satisfactory method requires the production of a series of photographs of the shutter at different stages of the exposure. If, then, a number of photographs of the shutter be taken at known intervals throughout its period of operation, all the data required for calculating both the efficiency and the duration of exposure would be obtained. A method by which such a series of photographs can be produced has been devised by P. G. Nutting, Ph.D., of the Eastman Research Laboratory, and communicated by him in a paper read before the Royal Photographic Society. Briefly, the method is as follows. A light aluminium crown is provided with twenty small plane mirrors fixed vertically to its face. This crown of mirrors is rotated at a constant speed of fifty revolutions per second, and as the crown carries twenty mirrors there would be one thousand interruptions in a beam of light reflected from it per second. The crown is illuminated by means of an arc lamp, contained in a small projection lantern, the condenser of which is made to focus an image of the crater of the arc at the surface of the mirror. The duration of each flash of light is determined by the angular width of the beam at the condenser, as at this point the beam is limited by a vertical slide two millimetres wide. The reflected beam of light falls upon a simple lens, behind which the shutter to be tested is held. An image of the shutter is then focused by means of a small lens of about four inches focus on to the rim of an aluminium wheel, twelve inches in diameter, round which is fastened a band of negative cinematograph film. This wheel is enclosed in a light tight box, and is set in motion by means of a crank and gearing, all that is required being that the speed shall be sufficient to separate the different images of the shutter. If, then, a shutter be placed in such an instrument, and a photograph taken, on development of the band of film a number of separate images is obtained, each of which represents a kind of cinematograph record of the action of the shutter opening, from which the speed and efficiency can readily be calculated, measuring the areas of the separate photographs, and comparing them with the areas of the same number at the full aperture, giving the efficiency.

REMOVAL OF GREEN FOG.—Green, or " dichroic," fog, which used to be very prevalent, and is occasionally met with now, may be removed by a bleaching method, using a solution prepared according to the following formula given in *The British Journal of Photography*, June 26th, 1914 :—

Potassium bichromate	35 grains
Sodium chloride	240 ,,
Sulphuric acid (strong)	3 drachms 20 minims
Water	5 ounces

For use the above is diluted with from five to ten times its volume with water, and the negative to be treated is, after being well soaked in water, immersed in the solution until the finely divided metallic silver that gives rise to the dichroic fog is converted by bleaching into silver chloride ; and, as this change takes place readily before any appreciable action is brought about upon the silver forming the image itself, there is little risk of damaging the negative, if care is taken. Finally, the negative is washed, put into the fixing bath to decompose the haloid silver salt formed, and again washed to remove the " hypo " and silver salt. An acid solution of thiocarbamid has also been recommended for the purpose of removing green fog, prepared according to the following formulae :—

Thiocarbamid	64 grains
Citric acid	32 ,,
Water	7 ounces

The negative to be treated is first thoroughly washed to remove the " hypo " soluble silver salts, and then put into the thiocarbamid solution until the deposit giving rise to the coloured fog is removed. The negative is then well washed in running water and dried.

XUM

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.S.

THE EFFECT OF VACUUM FUSION ON THE MAGNETIC PROPERTIES OF IRON.—During the last two years Yensen has described the remarkable magnetic properties obtained by melting electrolytically refined iron *in vacuo*. By this process magnetic permeabilities as high as fifty thousand, accompanied by hysteresis losses of one-fifth to one-eighth that of the best transformer steels, were obtained. Yensen now finds that, with a high-grade commercial iron made by the open-hearth process, the vacuum treatment increases the maximum permeability from two to three times, and decreases the hysteresis loss by a corresponding amount. (Yensen, *Electrician*, July 21st, 1916.)

EFFECT OF ABSORBED HYDROGEN ON THE MAGNETIC PROPERTIES OF PALLADIUM.—Specimens of palladium are slightly paramagnetic, but how far this is due to traces of magnetic impurities is not evident. For more than forty years it has been believed, on the authority of Thomas Graham, that when palladium absorbs hydrogen its paramagnetism is strongly increased. Biggs finds, however, that, on the contrary, when palladium absorbs hydrogen its paramagnetism decreases, so that when saturated with hydrogen it becomes almost neutral. The observed effect is probably due to some interaction of the hydrogen and palladium, and not merely to the presence of the diamagnetic hydrogen in the palladium. The point cannot be settled, however, until more is known of the magnetic properties of hydrogen itself. Experiments in this direction are in progress (*Phil. Mag.*, July, 1916).

THEORY OF CRYSTAL DETECTORS.—The fact that some pairs of crystals and some crystals and a metal form a contact, which has a rectifying action when subjected to an alternating electro-motive force, is widely known owing to the use of such contacts as electric-wave detectors. The theory of the action of such contacts has received much attention, and a very interesting paper on the subject, by Owen, appears in *The Proceedings of the Physical Society* for June 15th, 1916. In 1913 Eccles showed that many of the observed phenomena could be explained by taking account of the thermo-electric properties of the materials in contact. Owen's theory is also chiefly thermo-electric, the factors employed in explanation being the Peltier effect and the temperature coëfficient of resistance. The large temperature coëfficient of resistance in the case of the mineral detectors explains the curious fact that the rectified current, due to alternating voltage, is in the opposite direction to that produced by heating the contact.

IGNITION OF GASES BY ELECTRIC SPARKS.—This is a subject of great interest both from a theoretical standpoint and from its importance in connection with mine explosions and the behaviour of internal combustion engines. Thornton (*Roy. Soc. Proc.*, XCII, May 6, 1916) finds that the shorter the spark distance the greater the spark, so that the volumes of the least igniting sparks are in a typical case the same for all spark lengths. The products of combustion are found to be ionised and to carry a positive charge. With hydrogen, propane, pentane, and carbon monoxide the difficulty of ignition increases gradually as the percentage of oxygen is reduced. Methane is ignited by the same spark, whatever the percentage of the gas may be; while ethylene is more inflammable in rich mixtures. The paraffins are inflammable between the limits when the combustible gas is double that required for perfect combustion, and when the oxygen is twice that required for perfect combustion, less one atom to the molecule of combustible gas. The results obtained furnish direct evidence that ignition begins by ionisation of the oxygen present in the mixture.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

THE TREND OF EVOLUTION.—Two fine notices of the late Professor Weismann have recently appeared, one by Professor and Mrs. W. N. Parker, the other by Professor Poulton. It is interesting that both refer to a remarkable passage in an address which Professor Weismann gave at Freiburg, in connection with the Darwin Centenary Celebration. We venture to quote it. "The human race will never consist of entirely unselfish saints; but I believe that the number of those who act on the basis of a purer and higher humanity, and in whom the care of the whole race overshadows that of s lf, will increase as time goes on, as we know it has done in the past, and has led to higher forms of religion and to higher ethical conceptions. . . . The theory of evolution has often been perverted so as to indicate that what is merely animal and brutal must gain the ascendancy. The contrary seems to me to be the case; for in man it is the spirit, and not the body, which is the deciding factor."

MINIMUM DIET.—Loeb has shown that five generations of vigorous banana flies can be reared on a culture medium as simple as that required for certain micro-organisms. It is conceivable that "an evolution of animals as highly specialised as insects might have taken place independently of the existence of green plants." Other experiments indicate that the nitrite and nitrate bacteria are able to form carbohydrates from carbon dioxide independently of light.

VOLE VIRUS.—Periodic plagues of voles are well known, and many attempts have been made to cope with them. One of these is to infect the rodents with a virulent microbe, which has been provided by Löffler and also by Danysz. The bacillus seems to be much the same in the two cases, and is regarded as allied to the *Bacterium coli*. It may be introduced by injection or with the food. In studying a recent plague of voles in Italy, Professor A. Splendore found a Coccobacillus in the blood of moribund voles, and he hopes to use this as a basis for another anti-vole virus.

TIDAL ZONE INSECTS.—A study by Arndt of insects and spiders found between high and low tide-marks has shown some interesting adaptations. Some of the insects of the Spartina grass area cling tenaciously to the blades, and others crawl about under gravel. Many are hard to drown; others beat a rapid retreat when the tide comes in. Those that undergo submergence lie low during the high tide.

ECONOMIC USES OF SHARKS.—The fins of sharks are much used, especially in China, as a basis for soups, but the fishes have many other uses. The liver is rich in oil; the flesh is sometimes canned, and used as food. The whole body is manufactured into "fertiliser." Shark-skin makes excellent leather for certain purposes, and "from it are manufactured," according to a recent report by Mr. Alvan Seale (*Philippine Journal of Science*, XI, No. 3, 1916), "the most expensive scabbards and coverings for sword grips, certain expensive morocco bindings, coverings for jewel boxes, and so on. The crude skin is also made into rasps for cabinet makers."

TRAPS OF THE ANT-LION.—As is well known, the larval ant-lion makes traps, or pitfalls, into which insects tumble. It conceals itself in the loose soil at the foot and has a large range of appetite. It moves always backward, never forward. Turner has recently shown that the characteristic pits are typically made by a series of concentric furrows, each deeper than the preceding. The movement is backward, but the head is used in removing the soil. So-called death-feigning often follows rough handling or the like.

FOSSIL OTOLITHS.

By COLONEL C. E. SHEPHERD (Indian Army).

(*Continued from Page* 184.)

THE Red and Coralline Crag deposits of the East Coast, Essex, Suffolk, and Norfolk yield comparatively a poor supply of fossil otoliths. Dr. Higgins,* in a paper he wrote in 1867, says, alluding to fossil otoliths: "The formations which have yielded them in the greatest abundance are the Crag [Coralline Crag], the Hoodwell, Highcliff, Bracklesham, Brook, and Bramshaw Tertiary beds, and the Gault of Folkestone. All the otolites from the Coralline Crag that I have yet had an opportunity of examining belong, without a single exception, to existing species of Gadoids, namely, cod, whiting, pollack, whiting pout, green cod, and so on. There is therefore every reason for believing that the portion of a skeleton of a fish from the Coralline Crag described in *The Geologist*, and with some hesitation referred to this family, was undoubtedly Gadoid." The paucity of species is apparent, and Mr. Alfred Bell, who has for years been collecting specimens in the Crag deposits, says: "Otoliths are not plentiful in the Crags, the Red Crag especially. I may have had through my hands perhaps one hundred specimens. I hardly think more"; and on another occasion he says that "with a man to dig, fill, and wash the stuff through a close-meshed sieve I only got two—possibly three—of these stones out of two hundred cubic yards of rich crag, picked over so carefully that it yielded six hundred and fifty to seven hundred species, and thousands of examples of shells, coral, etc., at Little Oakley (Red Crag), near Dovercourt." The paucity of otoliths is conclusive. In Figure 156 have been brought together in the top row three fossil otoliths from the Coralline Crag of Suffolk, with three otoliths of living fishes that assimilate to them. Number 1 has already been named *Ot.* (*Gadus*) *pseudo-aeglifinus*. It resembles Number 2, the otolith out of the recent *Gadus aeglifinus* (the Haddock). Number 3 is similar to that shown by Koken's 1891 paper (Taf. III, 9), which came from the Coralline Crag. The name he gave it, *Ot.* (*Gadidarum*) *anglicus*, is retained. It is very like Number 4, the otolith of the present-day *Gadus luscus* (the Whiting Pout). To emphasise the origin of Number 3, var *corallinensis* should be added.

Number 5 is identical in appearance with Number 6. This is an otolith out of *Gadus merlangus* (the Whiting). The name *Otolithus* (*Gadidarum*) *premerlangus* would seem suitable to Number 5. These two otoliths have each a piece of the pointed end broken off. In existing fishes these points are very brittle. The fossil one seems to be the same. Number 7 is from the Red Crag of Suffolk. It resembles Koken's 1884 paper (Taf. IX, Figure 4), which he calls *Ot.* (*Phycis*) *elegans* var *sculpta*. That name is retained. Figure 8, the otolith of a young specimen of *Raniceps raninus*, resembles the last one in shape, but the mouldings are not so delicate. Number 9 is from the Gault at Folkestone. It seems much water-worn, and there are no distinct recognisable markings on it. Still, from the generally stout build of the stone, it is probably derived from some Gadoid fish, and might, if only provisionally, be called *Ot.* (*Gadidarum*) *Gaultina*. The sulcus of Number 10 is similar to one shown by Professor Schubert in his 1906 paper (Taf. IV, 4 and 5), which he has named *Ot.* (*Atherina*) *Austriacus*. The recent species, *Atherina hepsetus*, shows a similar sulcus. The allocating of this stone to *Ot.* (*Atherina*) *Cantiana* would seem correct, as it, like the last, was got from the Folkestone Gault, Kent.† Atherina is represented by several species in the Upper Eocene of Europe (see "Camb. Nat. Hist. Fishes," page 640), but did they go back to the Gault period?

Figure 157 shows fossil otoliths from Pliocene strata, Monte Gibio, near Modena, Italy. Number 1 is allotted to the Berycidae, (*a*) representing *Ot.* (*Berycidarum*) *sulcatus*, (*b*) *Ot.* (*Berycidarum*) *tuberculatus* (see Professor G. G. Bassoli's paper, "Rivista Italiana di Paleontologia," Anno XII, 1906); but the allocation to this family is not agreed to. It would seen more correct to give these otoliths to the Scopelidae. The reasons for the change will be adduced further on. Numbers 2 to 5 inclusive are given to the Macruridae: *Otolithus* (*Macrurus*) *Toulai*, (*M.*) *Arthaberoides*, (*M.*) *gracilis*, and (*M.*) *ornatus*. The inner faces, of Numbers 3 and 4 especially, show marks of sculpturing which, as noted before when writing of *umbonatus*, is unusual.

Number 6 is ascribed to *Ot.* (*Ophidium*) *Pantanellii*. Number 7 is undoubtedly a Sciaenoid otolith, and quoted as *Ot.* (*Sciaena*) *speciosus*, after a name given by Koken's 1891 paper (Taf. VII, 2 and 2*a*). Number 8 is *Ot.* (*Hoplostethus*) *premediterraneus*. The sulcus agrees completely with that of the present-day species of the same name. The outline, however, differs. Number 9

* "On the Otolites [*sic*] of Fishes and their Value as a Test in Verifying Recent and Fossil Species," E. T. Higgins, *Jour. Linnean Society*, Vol. IX, 1867, page 164.

† The courtesy of a loan by the Director, Brit. Mus. Nat. Hist., enabled the Crag and Gault fossils to be photographed for this article.

XUM

is allocated to *Ot.* (*Hoplostethus*) *orbicularis*. This name seems justified by the sulcus and outline. Number 10 is given to *Ot.* (*Percidarum*) *arcuatus*. Under modern classification the family name would read as (*Serranidarum*). This otolith is very similar to that already noted on in Figure 154 (8a). Number 11 is given to the Sparidae under the name of *Ot.* (*Sparidarum*) *mutinensis*. Number 12 is quoted as *Ot.* (*Deutex*) *speronatus*. *Deutex vulgaris* of the present day belongs to the family of the Sparidae. The sulcus of *D. speronatus* agrees with the family form. Number 13 is given as corresponding very nearly with *Otolithus* (*Gobius*) *aff. vicinalis** of Koken. Professor Bassoli, in his description in the letterpress on this otolith, says: "Although very near, I do not think it is possible to identify it with *vicinalis* of Koken." The allocation to the Gobiidae is, however, correct.

Exception, as stated *ante*, however, must be taken to the allocation of Figure 157 (1), to the Berycidae. The two upper specimens show the inner faces. The sulcus comes out clearly in each. They may be described as a straight furrow showing a double loop (the colliculi), the smaller one being in the cauda. This in no way corresponds with the sulcus of the present-day Berycidae.

A sketch of the sulcus of a typical Beryx is here given. The difference is self-apparent. Professor Bassoli seems to have been led astray by Professor Procházky, as he quotes Procházky in his letterpress descriptions. He also quotes Professor Schubert's 1905 paper. This author also seems to have followed Procházky's 1893† lead, and makes the same error. He shows in his Taf. XVII nearly a full page of illustrations of what may be called the "double-loop type" allotted to Berycidae, which are consequently wrong. Having demonstrated what they are not, it is more difficult satisfactorily to allocate them to what family they should belong. Professor Koken, in his 1884 paper (Taf. XI, Figures 8, 11, 13), shows three examples of the double-loop pattern; but these sulci extend fully across the length of the stone. He gives them to the Gadidae in which the sulci often so extend. This would negative the otoliths of Figure 157 (1), belonging to the Gadidae, as the sulci of the stones under discussion terminate abruptly clear of the further edge. The next nearest illustrations that have been published already are those shown by Professor Priem in his 1911 paper (page 45) and his 1912 paper (page 247), which he allocates to Scopelidae, as mentioned *ante* when discussing Figure 156 (14). The similarity to the sulcus of *Scopelus punctatus* may therefore safely allow that the allocation of Figure 157 (1) may be changed from the Berycidae to the Scopelidae, and that all similarly erroneous Berycidae should be changed also.

The Monte Gibio otoliths are found in clay strata. They are very numerous, and are found lying on the surface, in the beds of the streams, and also buried in the soil.

The Barton Clay otoliths are found in the bed of that name that is exposed near Barton, and also under Highcliffe, Hampshire, sometimes found on the surface and sometimes embedded, and occasionally in sand pockets, out of which they are sifted. From a large sand pocket at Highcliffe that Mr. Walton dug out this summer (1915), he tells me that up to now, from a quantity sifted, he has got only four otoliths, although there were many fish vertebrae and bones in this sand. On the other hand (also this summer), he noticed on the Barton Cliff a small mound of a reddish colour. He removed some of the clay, and put all the contents he could procure into his handkerchief. On arrival home he sifted it, and obtained one hundred and fifty or more otoliths. Some years ago he was examining some clay. He discovered that a portion of it was of a brownish colour, very different from the ordinary kind. He got a quantity of it out. It contained a large quantity of otoliths, as well as sharks' and other fishes' teeth. The otoliths seem, then, to have been deposited all over the clay, and afterwards to have been washed down into pockets, these being found, and naturally, in larger numbers in the sandy pockets; whilst others are still embedded in the clay.

So far all the otoliths mentioned have been those of marine fishes. There is only one instance of a British freshwater fish otolith recorded; that is, one ascribed by Mr. E. T. Newton as belonging to *Acerina cernua*, one of the Percidae. Professor Schubert mentions Sciaenoid otoliths as being found in freshwater deposits, near Brunn, in the mountains, in his paper on the Austro-Hungarian Sciaenoid otoliths. The Sciaenidae are represented at the present time in both salt and fresh water, but very much more largely in the former.

A detailed description of unpublished fossil otoliths is given. The length, breadth, and thickness are from typical specimens. The breadth has always been taken across the middle part of the stone. As will be seen in the photographs, the size varies, due to the age of the fish.

Otolithus (*Apogonidarum*) *circularis* (Figure 154 (3); L., 5·2 mm.; B., 4·5 mm.; T., ·7 mm.).—A sulcus with a well-opened ostium, joining the cauda on the lower side, with a free curve, the crista inferior in a straight line. The crista superior has a downward turn towards the end of the cauda that at first sight gives the impression that the cauda is bent. The sulcus extends from the frontal to the caudal border. Above the sulcus is a well-defined oval depression. The concavity

* For the original otoliths and the allocations above noted thanks are due to the courtesy of Professor G. G. Bassoli.

† *Rospravy Ceské Akademie Césare Frantiska Josefa*, Rocnik II, Trída II, Císlo 24, Tab. II and III (Vlad. Jos. Procházky).

of the outer face is feeble. The general shape of the stone is circular. Rather scarce.

Otolithus (*Apogonidarum*) *Eocenicus* (Figure 154 (4); L., 4 mm.; B., 3 mm.; T., 1 mm.).—A rather water-worn right-side otolith. The traces of the sulcus resemble that described above. The depression above the sulcus is of similar shape and well defined. This stone is rather longer than broad, the contour of the dorsal border going up into a peak; the lower border curved. A slight projection on the frontal edge. Like the last one (*A. circularis*) the concavity of the outer face is feeble. The umbo stands well up. Abundant in the Barton Clay.

Ot. (*Apogonidarum*) *nota* (Figure 154 (6); L., 2·5 mm.; B., 2 mm.; T., ·5 mm.).—A right-side otolith (water-worn). The sulcus similar to the last two described. The depression above the sulcus takes the form of a dent, such as would be made by a finger-nail in wax, rather than the oval-shaped depression of the former ones described; the outer face feebly concave, and marked with striae radiating from the umbo.

Ot. (*Gadidarum*) *Waltoni* (Figure 154 (5); L., 4 mm.; B., 2·4 mm.; T., 1 mm.).—The sulcus and general contour resemble that of *Ot.* (*G.*) *mucronatus*, as shown by Koken (see *ante*). The rather more pinched-in portion, representing the cauda, tends to differentiate the two. The sulcus stretches nearly, but not quite, the length of the stone, the ostium being long and narrow, the cauda much shorter, the two colliculi very apparent. From the point of the cauda a thread-like furrow, not apparent in the photograph, bends down and follows the ventral edge of the stone, reuniting with the lower front edge of the ostium. In the contour of the stone a prominent point projects at the top frontal edge. The caudal extremity runs to a sharp point. On the outer face a few prominent granulations are observable in well-preserved specimens. These otoliths are abundant in the Barton Clay.

Ot. (*Atherina*) *Cantiana* (Figure 156 (10) L., 12·2 mm.; B., 8 mm.; T., 2 mm.).—A small circular ostium with a straight cauda. The crista superior well defined; and, curving at the extremity, gives a quasi-appearance, as if the cauda were curved, but the lower crest is straight. The dorsal edge of the contour runs up to a peak, where it meets the posterior edge, the ventral edge with a well-rounded curvature. The outer face shows a few of the lines of growth.

Ot. (*Gadidarum*) *Galtina* (Figure 156 (9); L., 10·5 mm.; B., 6·5 mm.; D., 4·5 mm.).—A much water-worn stone. No useful indications of sulcus or mouldings are left.

Ot. (*Gadidarum*) *premerlangus* (Figure 156 (5); L., broken, 12·3 mm.; B., 4 mm.; T., 2 mm.).—A sulcus running fairly well the whole length of the specimen, the colliculi apparent. The outer face retains faint indications of the marking, the sloping shoulder on side, and the whole shape is similar to that of *Gadus merlangus* of the present day.

Ot. (*Pagellus*) *precentrodontus* (Figure 155 (1*a*); L., 7 mm.; B., 4·5 mm.; T., 1 mm.).—An elliptically shaped stone. A well-defined sulcus, with a moderate-sized ostium, a straight cauda arising from the same with a distinct downward curvature at the posterior end, and extending to the caudal edge. The concavity of the outer face is pronounced. The markings on this face radiate from the central umbo. The likeness to the recent fish, *Pagellus centrodontus* is marked.

Ot. (*Sargus*) *prerondolettii* (Figure 155 (1b); L., 5 mm.; B., 3·5 mm.; T., ·7 mm.).—The sulcus is generally similar to the last described, but the extremity does not curve so decidedly downward, although the crista superiore is deflected slightly at the extremity; but this extends but slightly to the crista inferior, the outer face with decided concavity.

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XUM

THE FACE OF THE SKY FOR NOVEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 49.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Nov. 1.....	14 25·4	S. 14·4	19 37·0	S. 21·6	13 35·9	S. 8·0	11 55·6	N. 2·0	1 50·8	N. 9·8	8 10·9	N. 20·1	21 13·9	S. 16·8	8 28·7	N. 18·8
„ 6.....	14 45·2	16·0	0 0·8	N. 5·3	14 6·0	11·3	12 17·6	S. 0·2	1 48·3	9·6	8 11·2	20·1	21 14·1	16·8	8 28·7	18·8
„ 11.....	15 5·3	17·4	4 23·6	N. 25·1	14 36·8	14·4	12 39·8	2·4	1 46·0	9·4	8 11·3	20·1	21 14·3	16·7	8 28·7	18·8
„ 16.....	15 25·7	18·7	8 42·0	N. 16·7	15 8·3	17·3	13 2·1	4·6	1 43·9	9·2	8 11·3	20·1	21 14·6	16·7	8 28·6	18·8
„ 21.....	15 46·5	19·9	12 27·3	S. 8·4	15 40·2	19·8	13 24·7	6·8	1 41·9	9·0	8 11·0	20·1	21 15·0	16·7	8 28·5	18·8
„ 26.....	16 7·7	S. 20·9	17 12·0	S. 25·7	16 12·8	S. 22·0	13 47·6	S. 9·0	1 40·2	N. 8·9	8 10·5	N. 20·2	21 15·5	S. 16·7	8 28·3	N. 18·8

TABLE 50.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2	Midnight. Moon. P
	°	°	°	°	°	°	°	h. m.	h. m.	°
Nov. 1 ...	+24·6	+4·2	246·6	Nov. 6 ...	−22·1	+3·2	174·5	41·6	7 14 *m*	0 55 *m*	Nov. 1	−10·5
„ 6 ...	23·6	3·7	180·7	„ 13 ...	22·3	3·2	200·4	14·2	6 31 *m*	1 41 *m*	„ 6	−23·0
„ 11 ...	22·5	3·1	114·8	„ 20 ...	22·4	3·1	226·2	346·5	5 49 *m*	2 27 *m*	„ 11	− 8·0
„ 16 ...	21·1	2·6	48·9	„ 27 ...	−22·6	+3·1	251·8	318·7	5 7 *m*	3 13 *m*	„ 16	+15·3
„ 21 ...	19·6	2·0	343·0								„ 21	+22·7
„ 20 ...	+17·9	+1·3	277·1								„ 26	+ 2·9

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-) graphical latitude and longitude of the centre of the disc. T is the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone; System II to the temperate zones which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m{\cdot}4$, $9^h\ 55^m{\cdot}6$ respectively.

The data for the Moon in Table 50 are given for Greenwich midnight, *i.e.*, the midnight at the end of the given day. Those for the planets were given for midnight last year, but are now given for Noon.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving Southward with slackening speed. Its semi-diameter increases from 16′ 9″ to 16′ 15″. Sunrise changes from $6^h\ 53^m$ to $7^h\ 46^m$; sunset from $4^h\ 35^m$ to $3^h\ 52^m$. There is now considerable solar activity, and a constant watch should be kept on the disc.

MERCURY is a morning star till the 24th, when it passes Superior Conjunction and becomes an evening star. Semi-diameter nearly constant at 2½″. Illumination $\frac{0}{0}$ at beginning of month, full at end.

VENUS is a morning star, well placed for observation. The semi-diameter diminishes from 8″ to 7″. Illumination of disc increases from $\frac{7}{10}$ to $\frac{8}{8}$.

THE MOON.—First quarter $2^d\ 5^h\ 51^m\ e$; Full $9^d\ 8^h\ 18^m\ e$. Last quarter $17^d\ 10^h\ 0^m\ e$. New $25^d\ 8^h\ 50^m\ m$. Apogee $16^d\ 2^h\ m$. Perigee $27^d\ 8^h\ e$. Semi-diameter 14′ 48″, 16′ 26″ respectively. Maximum librations $7^d\ 7°$ S., $9^d\ 5°$ W., $21^d\ 6°$ E., $22^d\ 7°$ N. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 53.)

MARS is low in the West and practically invisible.

JUPITER is in Aries; reached opposition October 24th. Equatorial diameter 48″, Polar 45″. Defect of illumination ¼″ at end of month.

Configuration of satellites at 10^h *e* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.	East.	Day.	West.	East.
Nov. 1	32 ○	14	Nov. 16	41 ○	2 3●
„ 2	1 ○	324	„ 17	○	123
„ 3	○	1234	„ 18	21 ○	43
„ 4	21 ○	34	„ 19	2 ○	134
„ 5	2 ⊙	34	„ 20	3 ○	24 1●
„ 6	3 ○	124	„ 21	31 ○	24
„ 7	312 ○	4	„ 22	32 ○	14
„ 8	32 ○	14	„ 23	13 ○	24
„ 9	14 ○	32	„ 24	○	1234
„ 10	4 ○	123	„ 25	21 ○	43
„ 11	421 ○	3	„ 26	42 ○	13
„ 12	42 ○	13	„ 27	431 ○	2
„ 13	43 ○	2 1●	„ 28	43 ⊙	2
„ 14	431 ○		„ 29	432 ○	1
„ 15	432 ○	1	„ 30	413 ○	2●

IV. is due north of the disc on the 17th.

The following satellite phenomena are visible at Greenwich:—$2^d\ 6^h\ 2^m\ 6^s\ e$ III Ec. R.; $3^d\ 5^h\ 4^m\ m$ I. Oc. D.; $4^d\ 2^h\ 15^m\ m$ I. Tr. I., $2^h\ 32^m\ m$ I. Sh. I., $4^h\ 24^m\ m$ I. Tr. E., $4^h\ 42^m\ m$, II. Tr. I., $4^h\ 42^m\ m$ I. Sh. E., $5^h\ 16^m\ m$ II. Sh. I., $11^h\ 30^m\ e$ I. Oc. D.; $5^d\ 1^h\ 59^m\ 38^s\ m$ I. Ec. R., $8^h\ 41^m\ e$ I. Tr. I., $9^h\ 1^m\ e$ I. Sh. I., $10^h\ 50^m\ e$ I. Tr. E., $11^h\ 4^m\ e$ II. Oc. D., $11^h\ 10^m\ e$ I. Sh. E.; $6^d\ 2^h\ 16^m\ 30^s\ m$ II. Ec. R., $5^h\ 9^m\ m$ III. Tr. I., $5^h\ 56^m\ e$ I. Oc. D., $8^h\ 28^m\ 26^s\ e$ I. Ec. R.; $7^d\ 5^h\ 16^m\ e$ I. Tr. E., $5^h\ 39^m\ e$ I. Sh. E., $5^h\ 49^m\ e$

TABLE 51. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m. s.	° ′		d.	
R Trianguli	2 31 53	+33 53	5·3 to 12·0	265	1916—Nov. 26
η Geminorum	6 9 45	+22 32	3·3 to 4·2	232	,, Nov. 1 (Min.)
Z Puppis	7 28 58	−20 28	7·5 to 14·0	516	,, Nov. 26
R Virginis	12 34 12	+ 7 27	6·2 to 11·1	145	,, Dec. 8
V Ursae Min.	13 37 10	+74 45	7·5 to 8·7	71	,, Dec. 6
R Draconis	16 32 25	+66 56	6·4 to 13·0	245	,, Dec. 5
S Draconis	16 41 7	+55 4	7·5 to 10·0	300	,, Dec. 8
R Aquilae	19 2 16	+ 8 6	6·2 to 11·2	335	,, Nov. 15
T Aquarii	20 45 27	− 5 28	6·8 to 13·4	203	,, Nov. 28
SV Cassiopeiae	23 34 55	+51 47	7·5 to 9·2	272	,, Nov. 26
V Cephei	23 52 21	+82 43	6·2 to 7·0	362	,, Nov. 10

Minima of Algol $7^d\ 6^h\cdot5\ m$, $10^d\ 3^h\cdot3\ m$, $13^d\ 0^h\cdot1\ m$, $15^d\ 8^h\cdot9\ e$, $18^d\ 5^h\cdot7\ e$, $30^d\ 5^h\cdot0\ m$. Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of β Lyrae $11^d\ 6^h\cdot2\ m$, $24^d\ 4^h\cdot3\ m$. Period $12^d\ 22^h\cdot1$.

II. Tr. I., $6^h\ 35^m\ e$ II. Sh. I., $8^h\ 21^m\ e$ II. Tr. E., $9^h\ 10^m\ e$ II. Sh. E.; $9^d\ 6^h\ 42^m\ e$ III. Oc. D., $8^h\ 4^m\ e$ III. Oc. R., $8^h\ 15^m\ 1^s\ e$ III. Ec. D., $10^h\ 2^m\ 58^s\ e$ III. Ec. R.; $11^d\ 3^h\ 59^m\ m$ I. Tr. I., $4^h\ 27^m\ m$ I. Sh. I.; $12^d\ 1^h\ 15^m\ m$ I. Oc. D., $3^h\ 55^m\ 0^s\ m$ I. Ec. R., $10^h\ 26^m\ e$ I. Tr. I., $10^h\ 56^m\ e$ I. Sh. I.; $13^d\ 0^h\ 34^m\ m$ I. Tr. E., $1^h\ 5^m\ m$ I. Sh. E., $1^h\ 18^m\ m$ II. Oc. D., $4^h\ 52^m\ 3^s\ m$ II. Ec. R.; $13^d\ 7^h\ 41^m\ e$ I. Oc. D., $10^h\ 23^m\ 49^s\ e$ I. Ec. R.; $14^d\ 4^h\ 52^m\ e$ I. Tr. I., $5^h\ 24^m\ e$ I. Sh. I., $7^h\ 0^m\ e$ I. Tr. E., $7^h\ 34^m\ e$ I. Sh. E., $8^h\ 6^m\ e$ II. Tr. I., $9^h\ 13^m\ e$ II. Sh. I., $10^h\ 38^m\ e$ II. Tr. E., $11^h\ 48^m\ e$ II. Sh. E.; $15^d\ 4^h\ 52^m\ 44^s\ e$ I. Ec. R.; $16^d\ 6^h\ 9^m\ 54^s\ e$ II. Ec. R., $9^h\ 58^m\ e$ III. Oc. D., $11^h\ 26^m\ e$ III. Oc. R.; $17^d\ 0^h\ 16^m\ 54^s\ m$ III. Ec. D., $2^h\ 4^m\ 0^s\ m$ III. Ec. R.; $19^d\ 3^h\ 0^m\ m$ I. Oc. D.; $20^d\ 0^h\ 11^m\ m$ I. Tr. I., $0^h\ 51^m\ m$ I. Sh. I., $2^h\ 19^m\ m$ I. Tr. E., $3^h\ 0^m\ m$ I. Sh. E., $3^h\ 34^m\ m$ II. Oc. D., $4^h\ 8^m\ e$ III. Sh. E., $9^h\ 26^m\ e$ I. Oc. D.; $21^d\ 0^h\ 19^m\ 18^s\ m$ I. Ec. R., $6^h\ 37^m\ e$ I. Tr. I., $7^h\ 19^m\ e$ I. Sh. I., $8^h\ 46^m\ e$ I. Tr. E., $9^h\ 29^m\ e$ I. Sh. E., $10^h\ 24^m\ e$ II. Tr. I., $11^h\ 52^m\ e$ II. Sh. I.; $22^d\ 0^h\ 57^m\ m$ II. Tr. E., $2^h\ 26^m\ m$ II. Sh. E., $6^h\ 48^m\ 14^s\ e$ I. Ec. R.; $23^d\ 4^h\ 43^m\ e$ II. Oc. D., $8^h\ 45^m\ 48^s\ e$ II. Ec. R.; $24^d\ 1^h\ 18^m\ m$ III. Oc. D., $2^h\ 52^m\ m$ III. Oc. R., $4^h\ 19^m\ 5^s\ m$ III. Ec. D.; $27^d\ 4^h\ 39^m\ e$ III. Tr. E., $6^h\ 25^m\ e$ III. Sh. I., $8^h\ 9^m\ e$ III. Sh. E., $11^h\ 13^m\ e$ I. Oc. D.; $28^d\ 2^h\ 14^m\ 52^s\ m$ I. Ec. R., $8^h\ 23^m\ e$ I. Tr. I., $9^h\ 14^m\ e$ I. Sh. I., $10^h\ 32^m\ e$ I. Tr. E., $11^h\ 24^m\ e$ I. Sh. E.; $29^d\ 0^h\ 45^m\ m$ II. Tr. I., $2^h\ 30^m\ m$ II. Sh. I., $3^h\ 18^m\ m$ II. Tr. E., $5^h\ 40^m\ e$ I. Oc. D., $8^h\ 43^m\ 50^s\ e$ I. Ec. R.; $30^d\ 4^h\ 59^m\ e$ I. Tr. E., $5^h\ 52^m\ e$ I. Sh. E., $7^h\ 1^m\ e$ II. Oc. D., $11^h\ 21^m\ 53^s\ e$ II. Ec. R. Eclipses of the satellites take place low right of the disc, taking the direction of the belts as horizontal.

SATURN is a morning star in Cancer; stationary on 12th; near Moon on evening of 15th. Polar semi-diameter 9″. Major axis of ring 44″, Minor 15″. Angle P $-7°\cdot3$.

East Elongations of Tethys (every fourth given) $2^d\ 6^h\cdot7\ m$, $9^d\ 8^h\cdot0\ e$, $17^d\ 9^h\cdot2\ m$, $24^d\ 10^h\cdot4\ e$; of Dione (every third given) $8^d\ 1^h\cdot1\ m$, $16^d\ 6^h\cdot1\ m$., $24^d\ 11^h\cdot1\ m$.; of Rhea (every second given) $2^d\ 6^h\cdot6\ m$,, $11^d\ 7^h\cdot5\ m$, $20^d\ 8^h\cdot5\ m$., $29^d\ 9^h\cdot2\ m$. For Titan and Japetus E., W. denote East and West Elongations; S., I. Superior and Inferior Conjunctions. Titan $5^d\ 1^h\cdot8\ m$ E., $12^d\ 6^h\cdot4\ e$ W., $21^d\ 0^h\cdot5\ m$ E., $28^d\ 4^h\cdot8\ e$ W. Japetus $13^d\ 4^h\cdot8\ m$ I.

URANUS is an evening star in Capricornus; in quadrature with Sun on 8th. Semi-diameter 1″·8.

NEPTUNE is a morning star in Cancer: stationary on 7th. Near Moon on morning of 16th.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Nov. 1 ...	43°	+ 22°	Slow, bright.
,, 2 ...	58	+ 9	Slow, bright.
,, 10–12 ...	133	+ 31	Very swift, streaks.
,, 14–16 ...	150	+ 22	Very swift, streaks, Leonids.
,, 16–28 ...	154	+ 41	Very swift, streaks.
,, 20–23 ...	63	+ 23	Slow, bright.
,, 17–23 ...	25	+ 43	Very slow, trains, Bielids.
,, 25–Dec. 12	189	+ 73	Rather swift.
,, 30 ...	190	+ 58	Swift, streaks.

GREENWICH TIMES OF MERIDIAN TRANSIT OF CERTAIN BRIGHT STARS.—These are given to facilitate the determination of time by observations with small transit instruments. The times for intermediate days may be obtained by simple interpolation. The Greenwich time of the stars crossing the meridians of other places may be obtained by expressing the longitude of these places in time, diminishing them by $9^s\cdot83$ per hour, and proportionately for fractions of an hour, then

TABLE 52.

Day.	α Aquarii. S. Dec. 0° 43′.	α Andromedae. N. Dec. 28° 38′.	α Arietis. N. Dec. 23° 4′.
	h. m. s.	h. m. s.	h. m. s.
Oct. 26	7 42 9·95 *e*	9 44 24·72 *e*	11 42 29·36 *e*
Nov. 5	7 2 50·72 *e*	9 5 5·57 *e*	11 3 10·33 *e*
,, 15	6 23 31·49 *e*	8 25 46·39 *e*	10 23 51·28 *e*
,, 25	5 44 12·26 *e*	7 46 27·15 *e*	9 44 32·19 *e*

XUM

applying the result to the tabular time—positively for West longitudes, negatively for East ones. (See Table 52.)

TABLE 53. Occultations of Stars by the Moon, visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reäppearance.	
			Time.	Angle from N. to E.	Time.	Angle from N. to E.
1916.			h. m.	°	h. m.	°
Nov. 2 ...	94 B Capricorni	5·7	8 36 *e*	9	9 17 *e*	292
,, 3 ...	WZC 1455	7·0	4 57 *e*	83	—	—
,, 3 ...	λ Capricorni	5·5	5 23 *e*	15	6 15 *e*	284
,, 3 ...	WZC 1460	6·8	9 6 *e*	50	—	—
,, 3 ...	96 B Aquarii	6·5	9 46 *e*	24	10 39 *e*	275
,, 4 ...	WZC 1515	7·0	7 26 *e*	63	—	—
,, 4 ...	WZC 1520	6·6	11 6 *e*	76	—	—
,, 5 ...	WZC 1576	6·6	9 25 *e*	101	—	—
,, 6 ...	WZC 20	7·2	9 57 *e*	18	—	—
,, 7 ...	WZC 70	7·1	6 48 *e*	69	—	—
,, 9 ...	ε Arietis (double)	4·6	8 9 *e*	349	8 22 *e*	326
,, 10 ...	104 B Tauri	5·5	5 7 *e*	52	5 55 *e*	278
,, 11 ...	36 Tauri	5·6	1 15 *m*	124	2 14 *m*	219
,, 13 ...	WZC 401	7·7	—	—	1 18 *m*	259
,, 13 ...	Lal. 12660	6·9	—	—	8 25 *e*	225
,, 14 ...	87 B Geminorum	5·8	3 17 *m*	63	4 18 *m*	327
,, 14 ...	63 Geminorum	5·3	—	—	8 4 *e*	270
,, 15 ...	79 Geminorum	6·3	5 28 *m*	180	5 59 *m*	227
,, 19 ...	WZC 705	6·6	—	—	1 39 *m*	287
,, 20 ...	388 B Leonis	6·3	—	—	1 55 *m*	326

From New to Full, Disappearances occur at the Dark Limb; from Full to New, Reäppearances.

Observers who know Greenwich Time can use the Table to obtain their South Point.

SUN before clock November 1, 979ˢ·39; November 6, 977ˢ·00; November 11, 954ˢ·11; November 16, 909ˢ·92; November 21, 844ˢ·36; November 26, 758ˢ·41; December 1, 654ˢ·17. These are the equations of time for the moment of solar transit at Greenwich.

VARIABLE STARS.—Stars reaching their maxima in or near November, 1916, are included. The lists in recent months may also be consulted. (See Table 51.)

THE INCISING AND CARVING OF BEAUTIFUL STONES.

IT is pleasant to find in a journal that is chiefly devoted to commercial subjects and trade topics a treatise from the pen of an enthusiast upon the subject of one of the fine arts.*

The art is one that has fascinated the human race from the earliest days of civilisation, but which is at the present time most undeservedly neglected except by a few artists who are producing objects of equal beauty to those belonging to the period when it and other arts flourished.

Mr. Leopold Claremont, who is known to our readers as an authority on gems, informs us that the incising of hard and beautiful stones with signs or devices for use as seals originated in extreme antiquity, and that the carving of the stones in bas-relief as ornaments and talismans; although, except in the case of the scarab, of much later date than the cutting of signets, is nevertheless of very early origin.

Of the ancient sigils, or signets, two are of special interest, namely, the cylinder seal and the scarab, the latter of which, besides being used for making raised impressions upon clay, was venerated as a sacred emblem by the Egyptians and some of the other early races.

The cylinder seal is something like a miniature garden roller, the surface of which is indented with a design or subject, instead of being smooth; so that, when the object is rolled over wax or clay, it leaves a raised impression.

"In different specimens the width of the engraved surface varies in proportion to the diameter of the cylinder, and it is usual for it to be considerably greater. The earliest examples of the cylinder seals are usually made of comparatively soft stone, such as steatite or serpentine, baked clay (faïence), wood, or ivory; but afterwards they were fashioned from such hard stones as agate, carnelian, amethyst, and crystal.

"The designs engraved round about them vary greatly in character, and these differences and other variations considered in conjunction with the materials used afford means of forming an opinion as to where and at what period of time the seals were made. Thus some cylinder seals of Egypt portray figures of men and animals in movement, and others are merely covered with patterns or hieroglyphics; and, again, the Assyrian cylinders often depict priests with sacred emblems, the ceremony of sacrifice, or portray creatures that are half human and half beast struggling with fearsome monsters, which are, as a rule, standing erect and gripping their assailants with their front claws and jaws; and on many the deity, consisting of a human figure with the head of a hawk, and bulls and lions endowed with wings are represented; also the Akkadian and Babylonian cylinders frequently exhibit deities wrestling with wild beasts.

"By means of a cord threaded through the hole in the centre the seals were generally carried attached to the wrist of the owner, but in some cases they were suspended from the neck or hung from the girdle."

The scarab is a representation in stone, faïence, or some other material of a beetle crouching upon an elliptical base, or platform, upon the flat reverse side of which is the engraving which was used anciently as a seal.

* "The Lure of the Glyptic Art," in the export number for August, 1916, of *The Watchmaker, Jeweller, Silversmith, and Optician* (Heywood & Company, Limited); price to non-members, 2/6.

FIGURE 168. Egyptian Cylinder Seal, with wax impression, of King Amenenhat, 21st Dynasty (?), blue faïence.

FIGURE 169. Assyrian Cylinder Seal with impression, grey Calcedony.

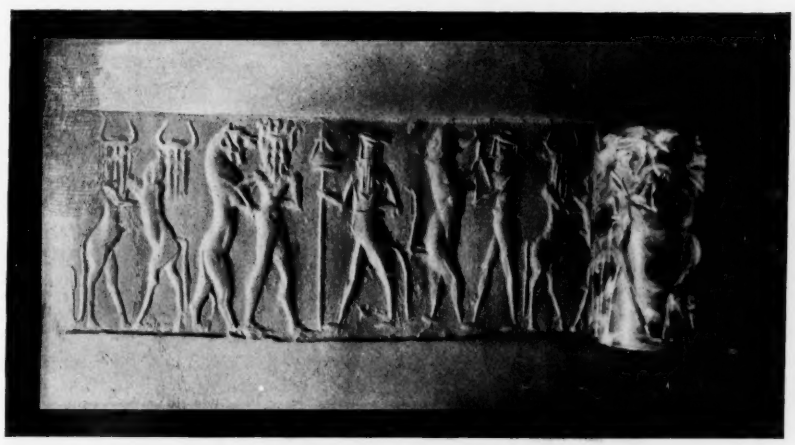

FIGURE 170. Babylonian Cylinder Seal with impression, black and white Onyx.

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FIGURE 171. Akkadian (Babylonia) Cylinder Seal with impressions, white Calcedony.

FIGURE 172. A Roman Cameo in Sardonyx.

FIGURE 173. A Roman Intaglio of the first part of the Third Century, with impression.

FIGURE 174. A Roman Cameo in Sardonyx.

FIGURE 175. Antique Cameo in Sardonyx.

In spite of the vast number of scarabs that have come to light in Egypt, and the great amount of study which has been bestowed upon them, there is still a good deal of mystery concerning them. There is no doubt that the form of the beetle which appears on the scarabs had a deep meaning connected with the faith of the Egyptian race, and that the underside of the platform, which in all cases is flat, was used as a seal; but to what extent either the religious sentiment or the practical use of the scarab predominated seems to be uncertain, for the authorities upon the subject are at variance upon the point.

Green basalt scarabs of large size were set in gold and hung from the necks of the departed over the heart. Many of them were inscribed with an extract from the thirtieth chapter of the "Book of the Dead," in which the deceased prays that "his heart may not be separated from him, and that no calumny may be uttered about him in the Hall of Judgment, and that the powers of the Underworld may not be hostile to him, and that the result of the weighing of his heart in the presence of the guardian may be satisfactory" (British Museum).

The art of sculpturing elaborate and delicate subjects or designs below the surface of stones, and of carving the stones in bas-relief, producing what are known as "intaglios" and "cameos," reached the height of perfection with the Greeks, and was continued by the Romans. It, however, vanished from Europe for about a thousand years to reäppear in Italy at the Renaissance.

Of this beautiful work the author writes as follows:

"The cutting of a cameo or an intaglio may be of any degree of elaboration. It may consist of a single object, such as the figure of an animal; or it may be literally a subject-picture in extreme miniature cut either in relief or sculptured below the surface, as the case may be.

"Also, there is little limit to the class of subject the artist may portray. For example, he may just as well choose for the purpose of his gem-cutting a group of dancing nymphs, with scarves of gauze, as battling warriors on prancing steeds. An immense amount of minute detail is therefore in some cases contained within the small space of the circumference of the gem. As the majority of the ancient gems depict incidents of the heathen mythology, and many of later date are either copied from, or inspired by, them, human figures—either nude or draped, in movement or repose, and grouped or posed to illustrate the idea of the artist—are commonly represented. The engraving of an intaglio may be shallowly or deeply cut, and the carving of a cameo may be in high or low relief.

"Different styles of cutting the gems prevailed at certain periods of the art, but the best effect is produced by a moderate depth of engraving and height of relief. The engraving of gems is, as a rule, executed upon a flattish or convex surface; but in a few cases ancient intaglios were incised from a concave surface, and there are extremely rare instances of a concave surface being carved anciently with a subject in bas-relief."

After indicating the extraordinary superstitions that were attached to the carved gems during the ignorant Middle Ages and afterwards, giving the reasons for them, the author describes the great profusion of carvings worn as ornaments in the sixteenth century and the mania throughout Europe for collecting the ancient gems, with its attendant impositions, that prevailed in the eighteenth century.

A good deal of space is devoted to describing how the precious stones of India are engraved with beautiful designs, how the opal is carved in bas-relief in modern times, and to the question of whether diamonds have been cut as intaglios, as asserted by other writers.

The following lines give Mr. Claremont's description of the method of carving the stones as cameos and intaglios:

"In remote antiquity it must have been discovered that a soft stone could be scratched by means of a harder one, and the earliest scarabs and cylindrical and other seals made of soft stone were doubtless fashioned by means of sharp points of flint, which were superseded by splinters of corundum, and possibly of diamond, as the art of carving stones possessing in a greater degree the power of resisting attrition was developed. There is no doubt that afterwards—yet still at a most remote age—the abrasive agent consisted of one or other of a series of tiny tools, presenting surfaces or edges of various shapes, which were endowed with a cutting power by means of powdered corundum and rotated by means of a bow, and later on by an apparatus resembling a modern lathe.

"Where necessary, cavities were made in the stone by means of a tubular drill which removed the material in the form of a core. By drilling a good many holes with this instrument, quite close to one another, and then breaking away the material remaining in between them, an excavation of almost any size could be made. The tubular drill was also used at a very early date for piercing stones.

"It was not until after the Middle Ages that an instrument was introduced which enabled an artist to cut off a fairly large slice of the stone, instead of grinding it away. This form of tool, which is now known as a 'slitter,' consists of a thin disc of soft iron, the edge of which is primed or impressed with an abrasive material, such as emery or diamond powder. It acts upon the principle of a circular saw, and by its means pieces of stone can be removed bodily by cuts made with the tool horizontally and vertically.

"To the use of this instrument can be attributed the greater width and evenness of the background, or margin, of many of the gems carved in modern times compared with those of ancient origin."

References are made to the carving of materials that are not stone, such as vitreous paste, lava, shell, and ivory, and the methods of performing the work, which in some cases are different from those used for the carving of stone, are described.

A few of the illustrations which accompanied this interesting article are here reproduced by permission of the author and the editor of the trade journal referred to.

REVIEWS.

CHEMISTRY.

A Textbook of Elementary Chemistry.—By ALEXANDER SMITH. 457 pages. 8-in. × 5½-in.

(G. Bell & Sons. 5/- net.)

The essentially practical character of American chemists is well illustrated in this textbook. One of its chief objects has been to provide a short manual for the use of those who do not intend to follow chemistry as a profession, but who wish to have a good grasp of the principles underlying chemical reäctions which present themselves in every-day life. At the same time, it is intended that the book may also form a stepping-stone to more purely chemical work. With these ends in view, the nature and properties of substances, typified by well-known objects, are first discussed, and this leads to the laws of chemical change and the characters of the more common elements and their compounds. Not until the meaning of chemical combination has been thoroughly dealt with is the influence of heat and energy introduced. Then come several chapters on the more important non-metallic and metallic elements and their chief compounds. Subjects, such as explosives, soaps, fuels, and plant life, are also treated at sufficient length for an elementary book. Each chapter and section is followed by series of questions intended to test, not only the memory, but also the thinking powers of the student.

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The method adopted is calculated to attract interest from the first, and the book may be warmly recommended as an admirable guide to all who wish to study chemistry without the help of a teacher, or to supplement his teaching. It is well illustrated with five plates of portraits of eminent chemists, including Sir William Ramsay, a plate showing fog-tracks from radium, and ninety-eight figures in the text.

C. A. M.

Chemistry in the Service of Man.—By ALEXANDER FINDLAY. xiv+255 pages, with 3 portraits and 23 diagrams. 9-in. by 6-in.

(Longmans, Green & Co. Price 5/- net.)

To attempt to bring home to the "man in the street" the importance of matters scientific is always praiseworthy, but never more so than at a time like the present, when most of the great nations are at war.

"War is war, and war is destruction." One combatant opposes his weapons to the armour of his adversary. He seaches for the weak place in the armour. The armour is not always of steel or triple brass.

Dr. Findlay in this work shows how dependent upon science is the daily life of the man in the street, and is at pains to point out the weak place in our armour.

We are doing much towards strengthening and repairing the harness, and it is to be hoped that this work may have so wide a circulation that the layman may realise the importance of the man of science in peace time as well as during war.

The book is based upon lectures delivered before the United Free Church College, Aberdeen, and is therefore written, as the lectures are given, for non-scientific folk. The style is clear and the text is free from all unnecessary technicalities. It provides a very comprehensive survey of the activities of men of science generally, and chemists in particular, and is to be welcomed as an attempt to stimulate the spirit of enquiry amongst laymen.

J. P. M.

MATHEMATICS.

A Course in Descriptive Geometry and Photogrammetry for the Mathematical Laboratory.—By E. LINDSAY INCE, M.A., B.Sc. 79 pages. 42 diagrams.

(G. Bell & Sons. 2/6 net.)

This admirable little book forms No. 1 of the "Edinburgh Mathematical Tracts." As the author points out in his preface, "one of the most desirable attainments of the mathematician is the ability to form a mental picture of three dimensional systems with ease and perspicacity, an ability which cannot better be developed than by a course of descriptive geometry." "It is a singular and regrettable fact," he adds, "that in most British universities descriptive geometry has been omitted from the regular mathematical curriculum, and studied only in the technical classes." At Edinburgh this, however, is not the case, and the present tract embodies the course in descriptive geometry given to the students in the mathematical laboratory of that university—a course which seems very well adapted to achieve the end in view as above specified.

In the Introduction a clear explanation is given of the three most important methods—Monge's method of doubly orthogonal projection, the method of contours, and the method of perspective—of accurately representing three dimensional figures on a plane surface. An interesting section deals briefly with the history of the science. It appears that to a degree the method of orthogonal projection owes its evolution to the demands made on the science by the art of architecture; that of perspective to the demands of the art of painting. The main body of the course is devoted to the solution of problems by means of Monge's method, and practical examples are given for solution. The one important application of the contour method, viz., to topographical surfaces, is dealt with in two sections, and there is a chapter devoted to the solution of perspective problems. A final chapter treats of photogrammetry—*i.e.*, "the obtaining from ordinary photographs" (or "photograms," as they should, points out Mr. Ince, be called) "correct metrical representations of the object photographed"—an application of descriptive geometry of considerable practical value in meteorological research.

H. S. REDGROVE.

PHYSICS.

Experimental Electricity and Magnetism.—By M. FINN, M.Sc. 436 pages. 181 illustrations. 5-in. $\times 7\frac{1}{2}$-in.

(Bell & Sons, Ltd. Price 4/6.)

It has been well said that young physicists should be taught as if intended to be either researchers or engineers. The author of this excellent book treats his readers as if they already had in them the germ of research and the love of construction. This is true of most of the boys in the upper classes of a good secondary school; and, if they are taught on the lines of this treatise, they will imbibe knowledge in such a way that their interest in the subject grows with their progress, so that it will be a lasting pleasure and a real educational influence all their lives.

There are many differences between this book and the orthodox work on electricity and magnetism. Its illustrations are new, the student starts doing interesting things from the first, and the order in which the subjects are treated is that best suited for the experimental method of teaching. The whole book bears evidence of being written by a man whose heart is in his work, and who not only knows what he is writing about, but how it should be taught.

J. H. V.

A NEW ADDITION TO THE BRITISH FLORA.

THE flora of Great Britain—and the same remark applies to that of other civilised countries—is being continually enriched by the addition of alien plants, which manage to establish themselves in one way or another. Our rivers, for instance, are full of the Canadian Water Thyme (*Elodea canadensis*), and the banks of many of them, as, for example, the Lea, are beautified by the North American Yellow Monkey Flower (*Mimulus luteus*). Indeed, there is reason for thinking that most, if not all, of the weeds that grow on cultivated land, such as the excessively common Shepherd's Purse (*Capsella bursa-pastoris*), are really alien plants whose seeds have been introduced as an impurity mixed with the seeds of cultivated plants.

This summer I found growing from between the stones on the beach at Cobb, Lyme Regis (Dorset), the beautiful *Tritonia potesii*, a near relative of the Iris—a plant much cultivated in gardens, and better known, perhaps, under the name of "Montbretia." The plant is a native of South Africa, and what I saw had no doubt escaped from cultivation. I counted about sixteen shoots of it, two of which were in flower, so that it appears to have well established itself at this station. I know of no flora which mentions the occurrence of this plant in Great Britain in a pseudo-wild condition.

H. STANLEY REDGROVE, B.Sc., F.C.S.